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Geological Survey of Alabama, Report of progress for 1879 and 1880. Eugene A. Smith, Ph.D., State Geologist. 8vo, pp. 158, with map. Montgomery, Ala., 1881. From the author.

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# GENERAL NOTES.

## BOTANY.[1]

THE GROWTH OF STARCH GRAINS.—At the suggestion of the editor of this department, I have prepared the following résumé of the results of my recent investigations. A fuller account appeared in *Bot. Zeit.*, 1881, No. 12 *et seq* (Untersuchungen über das Wachsthum der Stärkekörner).

The investigation of the development of starch grains yields several facts altogether unreconcilable with the well known theory of Nägeli, according to which they grow by intussusception. It was found that the middle part of the grain is formed first and the outer parts successively deposited around it. This is shown by the characteristic corroded structure of the small grains of many young organs, which can still be recognized very easily in the central part of the old grains, and by the comparison of grains of different age.

The corroded structure is due to the well-known circumstance that the starch of young plant-organs is only a transitory deposit which is partially used up again for the formation of cell-walls. The storing up of definitive starch begins only when the organ has reached its definitive size, and takes place partially around the remnants of the transitory grains, and partially by the formation of new grains which are of spherical shape and of course without any corroded appearance. These statements were based on observations made principally upon the starch grains of the cotyledons of *Dolichos Lablab*, *Vicia Faba* and those of the stem of *Cereus speciosissimus*.

Nägeli's theory, however, seemed to be firmly established by the following properties of starch-grains: (1) Their being made up of regularly alternating more and less watery layers, the outermost being always least watery (densest). (2) The difference of consistence between small grains and the middle part of the large ones, the first being very dense, the latter very watery. (3) Their unequal growth in different directions. (4) The growth of compound and half compound grains being, according to

[1] Edited by PROF. C. E. BESSEY, Ames, Iowa.

Nägeli, strongest between the nuclei, while growth by apposition would only take place at the periphery of the grains. (5) The partial grains of compound and half compound grains being more watery than simple grains of similar size.

In the discussion and explanation of these properties, the remarkable inner differentiation of starch-grains is first considered. The development of simple granules which was found to agree in the most important points with the observations of Nägeli, excepting the peculiar properties above referred to and belonging to a limited number of plants, may be summed up as follows: (1) Young grains consist of very dense, highly refractive substance. (2) Later a less refractive, more watery spot (nucleus) appears in the center. (3) More aged grains have three or several layers, the outermost being always very dense and highly refractive. (4) The inner substance becomes more watery as the grains increase in size.

According to the generally adopted views of Nägeli, these facts are held to prove that the inner structure is not due to a successive deposit of alternating more and less dense layers around a highly watery primary grain, but that the more watery layers and the nucleus have been differentiated within the less watery substance. The investigation of the physical properties of starch-grains leads, however, to an explanation of these properties which by no means requires the adoption of the theory of growth by intussusception. These properties are the following: (1) Starch grains are rather brittle parallel to the layers, but very extensible perpendicularly to them. (2) Cutting, crushing or extension causes the dense starch-substance to swell up considerably and to take all the properties of the more watery parts of intact grains. (3) Swelling up in water is much stronger parallel to the layers than perpendicularly to them.

Nägeli holds that the tensions, the presence and intensity of which he clearly recognized, are due to the intercalation of new starch molecules being greater in the tangential than in the radial directions; according to him these tensions would cause the formation of a central cavity in the homogeneous young grain, and later the division of the dense layers; and in the so-formed spaces a deposit of watery starch would take place. These views have not been confirmed; firstly, as to the cause of the tensions, which are due not to the unequal intercalation of starch-molecules, but to the unequal swelling up in different directions; secondly, as to the formation of a cavity and clefts in the homogeneous grains. The properties of starch granules above referred to, show that in such circumstances not a breaking but only an extending of the substance would take place, this causing the dense substance to become more watery and less refractive; for such places, therefore, where the tensions are strongest (viz., the central part of the grain and the middle parts of the peripheral dense layers after

their reaching a certain thickness by apposition growth), the transformation of less watery to more watery substance will be performed; in other words, the nucleus and the less dense layers will appear. That the inner parts of the grains, taken as a whole, are less watery than the peripheral ones, is due also to their being extended by the latter.

The unequal growth of starch-grains in different directions was shown in a former paper[1] to be due to the unequal conveyance of material. Starch-grains which are formed in the inner parts of chlorophyll or starch-forming granules, and remain surrounded by them, have central nuclei. They become eccentric when they are formed at the periphery of chlorophyll or starch-forming granules, and show constantly the greatest growth where they are in contact with them.

The formation of compound grains was also described in the paper already quoted, and shown to be due to the growing together of free granules, and not, as Nägeli holds, to the division of simple grains. The development of half compound grains was investigated principally in the rhizome of Canna and found to be analogous. The structure of grains having their nuclei distant from each other, which led Nägeli to suppose an intense growing of the grains between them, is caused by their being formed at distant spots upon the periphery of the chlorophyll, or starch-forming granules. The differences in the density of simple grains and the partial grains of the half compound and compound ones, is due to the extension of the inner by the outer parts.

Nägeli, and after him most biologists, hold that starch-grains agree with protoplasm as to their molecular structure, and are to be considered as living bodies. There is no longer any reason for ascribing to them properties different from those of inert bodies; their cohesion and their optical properties prove conclusively that they are sphærocrystals; they differ from most crystals by their property of swelling up in water, but the so-called protein crystalloids, which agree with them in this property, are known to be crystals of proteic substances, and have been produced artificially under the same circumstances in which true crystals would have been formed.[2]—*A. F. W. Schimper, Johns Hopkins University.*

HARDINESS OF THE EUCALYPTUS.—The paragraph on p. 389 of the NATURALIST for May, requires qualification; what Baron Mueller no doubt said, was, that in the native places of growth the blue gum was uninjured sometimes when the thermometer fell to 20° or 15° Fahr. Luminose and hygrometrical conditions in connec-

[1] *Botanische Zeitung*, 1880. Translated in *Quarterly Journal of Microscopical Science*, April, 1881.

[2] These conclusions are based upon the researches of Schmiedeberg (*Zeitschrift für physiol. Chemie*, Vol. I), Drechsel (*Journal für praktische Chemie*, Vol XIX) and my own investigations (*Zeitschrift für Krystallographie*, Vol. V).

tion with thermometrical—indeed, all that we understand by the word climate, decide hardiness. In this case the *Eucalyptus globulus* will not stand even a white frost in many parts of the United States. In a letter to me Baron Mueller says that *Eucalyptus amygdalina* and *E. Gunnii* stand a much lower temperature in their own homes than the common blue gum, and are now being used to replace the celebrated plantations on the marshes near Rome, which were destroyed during the winter of 1879–80.—*Thomas Meehan.*

Curiosities in Tree Growth.—Some years since a gentleman in New Jersey pointed out to me what he thought to be a curious case of natural grafting. One of the boughs of a maple tree (*Acer rubrum*) had thrown off a branch which after growing to a length of several feet without branches, had again united with the parent bough, the two forming a smooth and perfect union. The matter was discussed among some friends distinguished alike in horticulture and botany, and it was decided that such a thing could not take place naturally. Recently a similar case has come to my notice in a tree whose location, in a remote portion of Arizona, places it almost beyond possibility that human agency could have been concerned. The tree is a variety of oak, common here, which no botanist seems at present willing to assign to any species.

As represented in figure 1, the bough forks at the point *a*, about three feet from the trunk. The two branches, after running nearly side by side for a distance of three feet, come together at

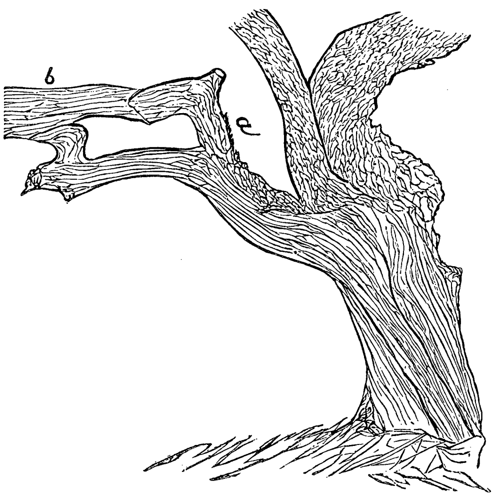


Fig. 1.

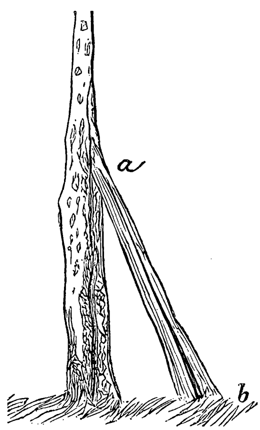


Fig. 2.

*b*, forming a smooth and perfect union. As the bough is dead and bared of its bark, the fibers of the wood can be seen with great distinctness. The "crotch" at *b* presents precisely the same

appearance that it would were the parent trunk toward *b*, forking in the direction of *a*. It is worthy of note that the bough beyond *b* has about the same diameter as inside of *a*, while at the branching part the wood is about equally divided between the two branches.

This interesting specimen has been forwarded to the Smithsonian Institution, where it may be seen.

Near this tree grows another, represented in figure 2, a specimen of *Platanus racemosa*, the sycamore of this section. Growing on the bank of the stream which runs through the bottom of a deep cañon, it seems to have been broken down by some of the rubbish carried against it during the rainy season. Breaking upon the upper side, a large mass of wood has been separated from the bark and protruded through the aperture. Later the tree has resumed the erect position. At the present time the entire cavity has been filled with new wood, and all traces of the wound bid fair to disappear. The mass of rubbish which has accumulated at the base of the tree gives the portion *a–b* the appearance of having been elongated.

Possibly such wounds are more readily healed in this country, owing to the irregularity and frequency of the periods of growth, corresponding to the great irregularity in the seasons of heat, cold, drouth and moisture.—*Henry H. Rusby.*

Botanical Notes.—The Characeæ of North and South America are now under a fair way to be elaborated systematically. Dr. T. F. Allen, of 10 E. 36th street, New York, who has already done such good work for some of our species, is making arrangements for enlarging the scheme of his *exsiccatæ* and illustrations so as to include the South American species. He requests all collectors to secure good specimens for him, and for those from South America he will make arrangements to pay liberally.——It is a genuine pleasure to call attention to the increasing usefulness of microscopical journals. The publishers of the *American Journal of Mircroscopy* deserve the thanks of students and teachers of botany for republishing, in the April number, a lecture on "How to examine a plant microscopically," by H. Pocklington (Leeds, Eng.). The article, which occupies eight pages, is a most excellent one, and cannot fail to do much good.——I. C. Martindale, of Camden, N. J., has issued a neat Catalogue of Desiderata (21 pp.), which may prove useful to other botanists also.——Professor Harvey's Classified list of the ferns of Arkansas, reprinted from the *Botanical Gazette*, enumerates thirty-nine species, and gives their range throughout the State.——Professor Dickson's paper on the morphology of the pitcher of *Cephalotus follicularis* in the *Journal of Botany* for May is interesting. He concludes "that the pitcher results from a calceolate pouching of the leaf-blade from its upper surface" somewhat as in the nectariferous petal of Aconitum, or as is shown better still in the petals of Aquilegia.

Incidentally he refers to the pitcher of Sarracenia as "corresponding morphologically to a peltate leaf like that of Nelumbium," but with the hollowed out depression of the upper surface much deepened and narrowed.——Morren's *Correspondance Botanique*, 8th edition, is a valuable aid to the botanical collector as well as the general botanist, giving as it does the address, title and special line of work of the more prominent botanists and collectors in all parts of the world.——We shall be doing a good service to many students by calling attention to the catalogue of works on natural history, just issued by Bernard Quaritch, 15 Piccadilly, London. Many rare and valuable botanical books are offered at moderate prices.——An important work, "Eléments de Botanique Fossile," by Edouard Bureau, is announced by the Paris booksellers as about ready.——Peter Henderson, well known for many years as a prominent horticulturist, has just published a "Handbook of Plants," which is designed to serve as a dictionary, or reference-book for the plants in cultivation either for use or ornament. It is especially adapted to this country, and is thus more valuable for Americans than Paxton's, Loudon's or Lindley's works. The arrangement is alphabetical for easy reference, but the natural order is indicated in every case. Instructions as to the best modes of cultivation are given in many cases, in addition to short descriptions of the plants. Not only will this book prove valuable to the horticulturist, but in many cases the botanist will find it indispensable also.

## ZOÖLOGY.

THE KING SNAKE (OPHIBOLUS SAYI) SUPS ON A FULL GROWN WATER MOCCASIN (ANCISTRODON PISCIVORUS).—"Be ye therefore wise as serpents."—Matt. x, 16.

The non-venom-secreting Ophibolus and the deadly Ancistrodon had kept a friendly companionship for several days in the same prison box. Well aware of each other's peculiar method of self-defence, there had been a policy truce instituted for the nonce. The former did not relish a hypodermic injection of poison from his surgeon neighbor, and the latter equally as much dreaded a fraternal embrace from his acrobatic companion. The one abhorred convulsions and tetanoid calisthenics as much as the other deprecated triturated ribs and macerated scales. The sky became suddenly changed, and such a change! &c., *vide* Byron. Without warning, the king snake instantly whipped a coil or two of its tail around the neck of his neighbor, just as the cracker of a whip doubles into a knot by the movement of the staff in the hands of a deft coachman. Before the moccasin could recover from the shock, its entire body was tightly pressed by the reduplicating folds of its agile enemy. From neck to tail and back again, its entire length was tied up so effectually that respiration became difficult, movement of the body was out of